# The Environmental, Resource, and Trade Implications of Biofuels

*This sheet summarizes some of the primary insights that arose from the Workshop on the Environmental, Resource and Trade Implications of Biofuels, which included 40 leading representatives of corporate, investment, government, non-government-organization, and academic communities. The Workshop, held in December 2006, was sponsored by the Woods Institute for the Environment at Stanford University.*

Biofuels have enormous potential to provide clean energy, reduce dependence on petroleum, and strengthen agricultural economies. The production of corn ethanol already has sparked a revitalization of rural communities in the U.S. and is poised to do the same in many other rural communities across the world. At the same time, a large-scale conversion to biofuels could adversely impact land and water resources, biodiversity, climate change, and social welfare. Achievement of the full potential of biofuels will depend on fully understanding and addressing the broad range of consequences associated with their widespread use.

Until recently, little attention had been paid to the broader set of environmental, resource, and trade issues associated with the development and implementation of biofuels systems; in many cases, our understanding of the associated costs, benefits, and opportunities remains incomplete. Further research is critical: new levels of cooperation across a wide range of disciplines, and new analytical tools are needed to help decision makers evaluate the local, regional, and global impacts of proposed actions.

**1. Some environmental benefits of corn ethanol and soy biodiesel may be overstated.**

Research estimating ethanol's greenhouse gas (GHG) impact and local air emissions should continue, with an emphasis on developing consensus on high-level methodological differences.

- **Corn ethanol may not provide an advantage over gasoline with respect to GHG emissions**. Most biofuel lifecycle analysis models (LCAs), which provide the bases for GHG impact estimates, are incomplete in a number of significant ways. For example, most conventional LCAs do not adequately account for many pollutants that affect climate. Some recent LCAs, which have attempted to be more comprehensive, suggest that future average corn ethanol and soy biodiesel systems could have similar or greater GHG emissions than future gasoline or diesel fuel, although the uncertainty in these estimates is large. Robust LCA models that fully capture and account for the factors listed above are urgently needed. (M.A. Delucchi, "Lifecycle Analyses of Biofuels" (University of California, Davis, 2006); www.its.ucdavis.edu/publications/2006/UCD-ITS-RR-06-08.pdf)
- **Ethanol may not provide an advantage over gasoline with respect to local air quality.** New research suggests that the use of a high-ethanol blend (E85) provides no improvement in local air quality, and its associated health effects, relative to gasoline; substituting E85 for gasoline likely would result in a roughly equivalent – or possibly greater – number of cases of air-pollution-related asthma, respiratory disease, and premature deaths in the U.S. (M.Z. Jacobson, *Environ. Sci. Technol.* **41**, 4150 (2007))

**Analyses of potential costs associated with a large-scale shift to biofuels should continue.** In some cases, as with agricultural impacts, refinement of an existing body of research is needed; in other cases, as with food security implications, basic research questions still must be answered. Potential adverse effects associated with a large-scale shift to biofuels include:

- **accelerated destruction of natural ecosystems such as rainforests, wetlands, and native grasslands,** and cultivation of some environmentally sensitive lands that have been set aside from agricultural production under governmental conservation programs, due to increased demand for agricultural commodities. The higher the price for agricultural products, the greater the incentive to convert ecologically valuable areas into croplands.
- **increased CO2 emissions, agricultural runoff and soil erosion,** as farmers increase total land under cultivation (and burn forests or till long-fallow lands), expand into marginal lands not ideally suited for agriculture, and take measures to enhance the productivity of lands currently under cultivation.
- **increased food insecurity and malnutrition,** due to a rise in food prices and a reduction in commodity surpluses. The increased demand for energy crops could edge out the supply of food commodities and cause food prices to rise. While some poor farmers stand to benefit from a rise in commodity prices, net food consumers could be hurt.

2. **How a transition to biofuels is implemented – the actions taken now – will significantly affect the nature and magnitude of biofuels' environmental and social welfare impacts.**

   **Mechanisms for mitigating the adverse impacts** associated with a large-scale shift to biofuels – such as promoting agricultural management and production choices that reduce ethanol's adverse environmental impacts – should be pursued. Some examples are: directing the expansion of agriculture away from virgin forests and native grasslands; utilizing best management practices, including no-till farming; and powering ethanol processing plants with natural gas or agricultural co-products or residues rather than coal.

   **Opportunities to create collateral benefits** – such as opening poor farmers' access to world markets by removing trade barriers, helping developing countries use biofuels technology to achieve economic growth and energy independence, and growing ethanol feedstock in a manner that restores degraded lands – also should be pursued.

3. **Innovation in high-leverage areas should be pursued. Some examples are:**

- **cellulosic technology** Not yet commercially scalable, cellulosic ethanol appears to represent an improvement over corn ethanol on almost every metric (with the notable exception of local air quality). If ethanol feedstock shifts away from food crops to grasses, agricultural and forestry residue, and the organic portion of municipal solid waste, ethanol could be produced with less interference with the food economy and with fewer impacts on water resources, air and land.
- **variable-feedstock processors** While current research and development of ethanol conversion technologies tends to focus on conversion processes suitable for a single type of feedstock, ethanol conversion facilities able to accept a variety of feedstocks likely would encourage a more environmentally friendly feedstock menu of perennial grasses and trees, enable processing at a smaller scale (suitable for developing countries), and eliminate logistical problems of feedstock storage and seasonal variations in volume. **(B. Paulos, G. Bonfert,** "The Machine in the Garden"; http://www.ef.org/biofuels)
- **sustainably achieved crop yields** Improving corn yields while minimizing the use of chemical inputs and water could reduce pressure to expand croplands while avoiding unnecessary harm to the environment. (See K. Cassman, V. Eidman, E. Simpson, "Convergence of Agriculture and Energy: Implications for Research and Policy", QTA 2006-3; http://www.cast-science.org)